

Compact Drive System for Planetary Rovers and Space Manipulators

Completed Technology Project (2013 - 2016)



Project Introduction

The overall purpose of this project is to study the development of a new articulated robotic arm aimed at improving the dexterity, modularity, strength, and torque output of current space manipulation systems. The key enabling technology for the proposed robotic arm is its novel joint, the Gear Bearing Drive (GBD). The GBD is a newly developed actuation concept based on NASA's high-reduction planetary gearbox technology and new brushless "outrunner" motor technology. Due to its unique arrangement of planetary transmission and drive motor, the GBD is able to combine the motor, transmission and position sensing elements into a space that is volumetrically smaller than a human elbow joint. This combination produces ultra-compact actuators with incredible high torque output (more than 100 Nm), micro-precision accuracy, and strong and rugged structural integrity. These unique characteristics of the GBD facilitate the development of high payload-to-weight robots that are otherwise unattainable with traditional actuators. The proposed project, which will focus on the design and fabrication of a six degrees-of-freedom space manipulator using the Gear Bearing Drive joint technology, is divided into three main milestones. The first milestone involves conducting research and development on the GBD to improve Technology Readiness Level from proof-of-concept (TRL 1) into proven full-scale feasibility validation (TRL 6). The second milestone involves designing and developing the space manipulator according to a specific NASA application. The third milestone comprises testing and demonstrating the system capability in aerospace applications and publishing results. The proposed manipulator is expected to bring unprecedented strength and dexterity advantage and deployment modularity to space-based robotic manipulators. The research will shed light on new mechanisms of actuation and introduce a new class of compact powerful actuators with the potential to impact a number of space technology disciplines from space humanoids to powered exoskeletons and planetary rovers drive systems.

Anticipated Benefits

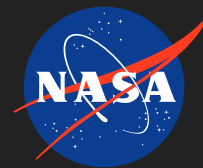
The proposed manipulator is expected to bring unprecedented strength and dexterity advantage and deployment modularity to space-based robotic manipulators. The research will shed light on new mechanisms of actuation and introduce a new class of compact powerful actuators with the potential to impact a number of space technology disciplines from space humanoids to powered exoskeletons and planetary rovers drive systems.



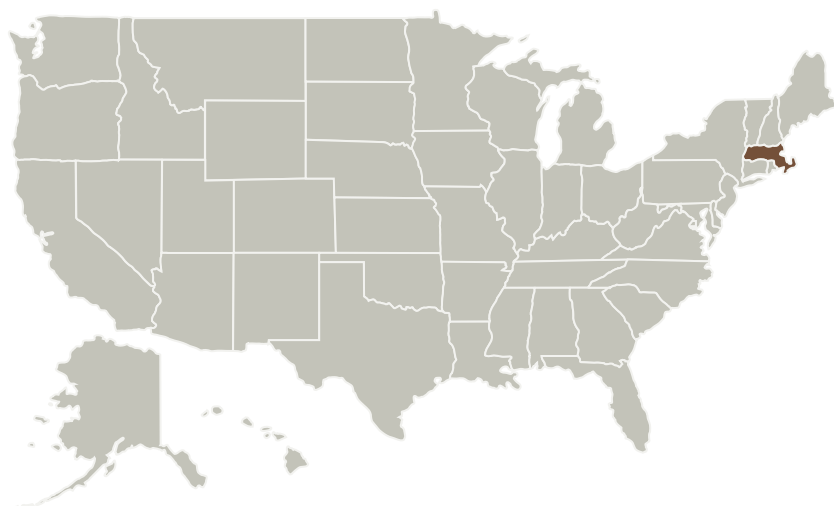
Compact Drive System for
Planetary Rovers and Space
Manipulators

Table of Contents

Project Introduction	1
Anticipated Benefits	1
Primary U.S. Work Locations and Key Partners	2
Project Website:	2
Organizational Responsibility	2
Project Management	2
Technology Maturity (TRL)	3
Technology Areas	3
Target Destinations	3



Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Northeastern University (NEU)	Lead Organization	Academia	Boston, Massachusetts

Primary U.S. Work Locations

Massachusetts

Project Website:

<https://www.nasa.gov/directorates/spacetech/home/index.html>

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Northeastern University (NEU)

Responsible Program:

Space Technology Research Grants

Project Management

Program Director:

Claudia M Meyer

Program Manager:

Hung D Nguyen

Principal Investigator:

Hanchen Huang

Co-Investigator:

Elias Brassitos

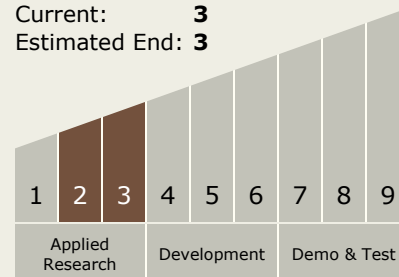
Compact Drive System for Planetary Rovers and Space Manipulators

Completed Technology Project (2013 - 2016)



Technology Maturity (TRL)

Start: **2**
Current: **3**
Estimated End: **3**



Technology Areas

Primary:

- TX11 Software, Modeling, Simulation, and Information Processing
 - └ TX11.2 Modeling
 - └ TX11.2.3 Human-System Performance Modeling

Target Destinations

Earth, Mars, Others Inside the Solar System